The impact of the minimum wage on employment and hours

Interim report

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Abstract

This paper describes the data and methods used for the identification and estimation of the effects of the introduction of the National Living Wage (NLW) and the upratings of the National Minimum Wage (NMW) on employment and working hours, with a special emphasis on the impact on young people. We propose a standard difference-in-differences (DiD), as well as a difference-in-differences-in-differences (DDD), methodology. The analysis will make use of two data sources: the five-quarter longitudinal Labour Force Survey and the Annual Survey of Hours and Earnings. We present here early findings from the analysis of the Labour Force Survey.

1 Introduction

The purpose of this paper is to set out the methods we intend to use to estimate the impact of the National Living Wage (NLW)/National Minimum Wage (NMW) on employment and hours, as well as presenting preliminary findings. It begins by listing the research questions and then moves on to discuss the datasets that will be used in the analysis, as well as the reasons why they are considered suitable. The following section provides details of the proposed approach and explains why we have chosen to focus on these methods. The paper also sets out how we will

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seek to address some of the limitations of the past literature. We then present early findings and our proposed next steps.

2 Recent policy developments and research questions

The aim of the research is to assess the impact of the introduction of the NLW in April 2016 and its successive uprating on employment and hours worked. From October 2010 until the introduction of the NLW in April 2016, the adult rate of the NMW applied to all employees aged 21 or more, but since April 2016 those aged 25 or more have been eligible to receive the higher NLW. Those aged between 21 and 24 now receive the adult NMW, whilst a lower youth development rate applies to those aged between 18 and 20. There are also different rates for those aged 16 or 17 and apprentices who meet certain criteria.

The main questions to be addressed by the research are:

- What impact has the introduction of the NLW had on employment and hours for workers aged 25 years and over?
- What impact has the introduction of the NLW had on employment and hours for younger workers (those under 25 years of age)?
- Has the impact of recent upratings on employment and hours differed for workers of different ages and by whether they work full-time or part-time?
- Has the impact varied by any other types of worker or employer characteristics?

Dickens et al. (2015) highlighted the importance of considering impacts for women working part-time and full-time separately, since negative employment effects were found only for female part-time workers. For this reason, our analysis will explore whether the impact of the NMW/NLW on employment and hours varies for women working part-time and full-time, as well as men. We will also seek to explore the interaction between participation in education and employment for young people and other employee and employer characteristics such as firm size, industry, occupation, geography, health status, ethnicity, educational qualifications and migrant status, where sample sizes allow.

3 Context

3.1 Evidence for adults

Since the introduction of the UK NMW in April 1999, extensive research has been conducted on its labour market effects. In common with findings on minimum

wages in other countries, most notably the US (Card and Krueger (2000); Card and Krueger (1994); Hirsch et al. (2015); Dube et al. (2010)), the evidence for the UK suggests that the employment effects of the NMW have been negligible. This result holds across different methodologies and outcome measures. For instance, Dickens et al. (2009) found little evidence that large increases in the NMW had a negative impact on job retention, entry or employment rates. Dolton et al. (2015) exploited the geographical variation in the bite of the NMW to identify its impact on total employment in local areas. They found no effects of the introduction of the NMW on employment once the spatial correlation among local areas was taken into account. The most recent analyses of the impact of the NLW on employment retention, by Aitken et al. (2017) has also found no conclusive evidence that the introduction of the NLW has affected employment retention.

The link between increases in the NMW and the number of hours worked has also been found to be fairly weak, although Stewart and Swaffield (2008) found that the introduction of the NMW resulted in a reduction of between one and two hours a week in total and basic hours for low-paid workers. The most recent study by Aitken et al. (2017) found very limited evidence that the NLW had an impact on the number of hours worked by those who remained in employment following its introduction. The analysis of the LFS found some signs that the introduction of the NLW resulted in a slight reduction in hours for women working part-time. This was contradicted by the analysis of ASHE, but there were signs that when using ASHE the assumptions underlying the methodological approach were violated. There was no evidence that the introduction of the NLW was associated with a reduction in hours for any other groups of employees.

Meta-analyses, such as those conducted by de Linde Leonard et al. (2014) and Hafner et al. (2016) have also found no evidence of significant adverse effects from the NMW on employment, employment retention, or hours when aggregated across all groups of affected employees. Hafner et al. (2016) also demonstrated that there is no selection bias in publications on the NMW in the UK.

Although the effects might be negligible when measured across all workers affected by the NMW, statistically significant impacts can still be found for specific sub-groups of workers. For instance, Dickens et al. (2015) found negative effects on employment retention for part-time female workers in large firms. The meta analysis by Hafner et al. (2016) found that across the UK studies there is evidence that the NMW has had an adverse impact on employment retention for part-time employees, except during the most recent recession. Dickens et al. (2012) also found a negative effect on employment retention for female part-time employees in large firms.[1] There is evidence that some groups of workers experienced a reduction in hours in response to larger increases in the NMW in 2001 and 2003

[1] Note, however, that in Canada Brochu and Green (2013) found that low-skilled workers with shorter job-tenure (less than a year) were less likely to leave their job following an increase in the minimum wage, whilst this was not the case for those with longer job tenure.

(Dickens et al., 2009).

3.2 Evidence for younger workers

The literature finds mixed results on the effects of minimum wages on young workers. Using a panel of 33 countries Dolton and Rosazza Bondibene (2011), found adverse employment effects, but these became statistically insignificant when the estimates were weighted by the size of the population in each country. Dickens et al. (2014) explored the impact on low-skilled young workers of moving from eligibility for the youth to the adult rate of the NMW and found a positive employment effect of around 5 percentage points, which is likely to be explained by young workers increasing their labour supply in response to the higher NMW rate. Fidrmuc and Tena (2013) used the same methodology as Dickens et al. (2010) to analyse the impact on young workers of all skill levels. They found no statistically significant effect on employment of turning 22 (i.e. moving from the youth to the adult rate of the NMW). However, they found a negative employment effect on young male and female workers turning 18 (hence moving from the lowest, to a higher, NMW rate). They also found that employment effects varied for firms of different sizes and in different sectors.

Using similar methodologies, Conlon et al. (2015) found no adverse employment effects on young workers after the introduction of a lower eligibility threshold for the NMW adult rate in 2010. The same study found positive employment effects of the freeze in the minimum wage in 2012 for eligible young workers. Brochu and Green (2013) found a generally negative employment effect of minimum wage increases along the whole age distribution, but a more pronounced negative effect on teenagers. Similarly, Bryan et al. (2012) found a more pronounced reduction in hours for young workers following the 2010 uprating of the NMW than for other groups.

The literature also considers whether the impact of the minimum wage on young workers varies depending on their age, labour market status and participation in education. Crawford et al. (2011) explored whether participation in education and employment by young people was affected by the youth rates and found a positive and statistically significant impact on the employment probability of full-time students aged 16-17 years old living in low-wage areas. However, they found little evidence to suggest that the NMW encouraged young people to leave education, or had a negative impact on their employment. This suggests that the youth rate created an incentive for teenagers to take-up part-time jobs whilst studying.[2]

[2] Crawford et al. (2011) used the Longitudinal Study of Young People in England (LSYPE) in addition to LFS and ASHE to explore the interaction between education and employment and the NMW for a cohort of young people who were in Year 9 in the 2003/2004 academic year. Whilst a new version of the survey has now been released for those in Year 9 in the 2013/14 academic year (LSYPE2), this is only

To summarise, the existing literature points to the existence of different labour market effects of the minimum wage depending on individual and firm characteristics, such as education, gender, part-time or full-time status, firm size, job tenure and skill-level. This suggests that a comprehensive analysis of the impact of the minimum wage should ideally separate out the effects according to these characteristics.

4 Data

In common with many previous studies and most recently Aitken et al. (2017), we will estimate the effect of the introduction of the NLW and the successive upratings of the NMW/NLW using individual-level analysis of the Labour Force Survey (LFS) quarterly longitudinal data and the Annual Survey of Hours and Earnings (ASHE) data. The following subsections describe the characteristics of each data source and the main variables of interest for our empirical analysis. We also explain the timeframe considered in the analysis.

4.1 Labour Force Survey

The LFS is conducted on a quarterly basis, with each sample household retained for five consecutive quarters, and a fifth of the sample replaced each quarter. It provides detailed background information on individuals. This can be used to improve the reliability of the impact estimates by controlling for characteristics which are likely to determine labour market outcomes. However, a relatively large proportion of responses (around one-third) are supplied by proxies, potentially affecting the accuracy of the data.

A number of studies (Frijters et al., 2005) have exploited the longitudinal dimension of the quarterly LFS and have linked information for the same individuals across up to five successive quarters. However, as noted by ONS (2017), linking the different quarters of the LFS might lead to two types of biases: non-response bias (due to attrition) and response error bias (which arises because individuals might give incorrect answers to the survey questions). The weights provided on the longitudinal LFS correct for non-response bias, including differential attrition by different subsets of respondents, and so these are used in the analysis presented here.[3]

currently available for the period up to September 2015 and so would not be suited to addressing the research questions at present.

[3] The fact that the longitudinal LFS contains weights (LGWT) which correct for attrition represents a significant advantage compared with an analysis based on combined wave 1 and wave 5 cases from the quarterly LFS. See beta.ukdataservice.ac.uk/datacatalogue/series/series?id=2000026 for details.

4.1.1 Key variables

Wages The wage variable that we use to identify treatment and comparison groups in the LFS is gross hourly earnings (HHRATE). This is considered the most accurate measure of hourly pay (ONS, 2017).

Employment retention In the LFS it is possible to observe whether an employee who is in work when they first join the survey is still employed one year later. This measure indicates whether the employee is with any employer, rather than whether they are in the same job or with the same employer.

Hours of work The LFS records total usual hours worked in the main job, excluding overtime, observed one year after the first wave in which the individual appeared. This includes those who changed jobs. Therefore a change in the number of hours worked could be due to the employee changing jobs, rather than an existing employer adjusting working hours.

Individual and workplace characteristics Our analysis controls for a wide range of individual characteristics such as: gender, education (highest level of qualification achieved), ethnicity, number of children, health status (whether had health problems in the last year), occupation, region, industry and tenure (with current employer, or in the labour market).

Some variables of interest are not present in the longitudinal dataset. For instance, workplace size is not included in the longitudinal LFS, which means that it is not possible to perform a sub-group analysis based on this characteristic using this particular data source.

4.2 Annual Survey of Hours and Earnings

ASHE is essentially a 1 per cent sample of employees of working age. It is better-suited to analyses of subgroups within this population than the LFS, as there is a lower likelihood that estimates of the impact of the NMW/NLW will appear statistically insignificant because the number of cases for analysis is too small. The larger sample sizes offered by ASHE are a particular advantage when looking at whether the impact of the NMW/NLW varied by age and in distinguishing between different groups of younger workers.

Prior to April 2013 ASHE was drawn from PAYE records. The fact that employers were not obliged to complete the P14 for employees earning less than the PAYE threshold meant that some employees paid the NMW and working few hours may not have been included in ASHE in earlier years. This deficiency was addressed with the introduction of a real time information reporting (RTI) system in April

2013.[4]

Employment retention We will use ASHE data on whether an employee was observed to be in employment in successive years. As with the LFS data, this measure includes those who were doing a different job, or were with a different employer. Additionally, the ASHE data record whether individuals were in the same job and so we will explore estimating the impact of the NLW/NMW uprating on this alternative outcome measure.

Hours of work The ASHE measure captures basic weekly paid hours (excluding overtime) in the job in which the employee works most hours, observed one year apart. Where an employee worked the same number of hours in more than one job, the job that was identified as the main job is chosen. Whilst the measure focuses on the hours worked in the main job at each point in time, it includes employees who changed jobs or employers.

4.3 Timeframe for analysis

To avoid potential confounding effects of the economic crisis on the outcomes of interest, we focus on the years from 2011 onwards. In the analysis focusing on the effect of the introduction of the NLW and its upratings we treat 2011 to 2015 as the pre-intervention period. To account for the NMW upratings that took place prior to the introduction of the NLW in 2016, we estimate a specification which weights the estimates by the size of the earlier upratings and treats the introduction of the NLW as a particularly high uprating.

5 Empirical models

Both ASHE and the longitudinal LFS datasets follow individuals over time and hence make it possible to compare the outcomes of interest before and after each minimum wage uprating for the group of workers affected by the policy (the treatment group) and similar workers not affected by the policy (the comparison group). Our baseline models use standard difference-in-differences (DiD) regressions comparing outcomes one year apart, falling before and after the introduction/uprating of the NLW or the NMW.

[4] Subsequent analysis has found that in practice most jobs were already included in the PAYE returns made by employers. As a result, the discontinuity arising from the introduction of RTI is not considered by ONS to have any implications for the ASHE time series. As ASHE is completed by employers and participation is mandatory, it is thought to provide a more reliable source of information on wages than the LFS, as it is likely to be drawn from payroll records, rather than relying on recall. However, ASHE lacks the detailed information on employee characterstics which is available from the LFS. This reduces the likelihood of being able to control for employee characterstics when seeking to estimate the impact of the NMW on employment and hours.

In addition to a standard DiD analysis, for the analysis related to the introduction of the NLW using the ASHE data, we will explore estimating a difference-in-differences-in-differences (DDD) model. This exploits the fact that the introduction of the NLW created two ccomparison groups:

- an age comparison group of individuals who were ineligible for the NMW due to their age i.e. they were under the age of 25, but earning less than £7.20 per hour and;
- a wage comparison group of individuals aged 25 or more but earning slightly more than the incoming NLW.

The following subsection provides further details on the empirical models.

5.1 Difference-in-differences

Each of the five-quarter longitudinal LFS datasets spans a minimum wage uprating between the first and the last interview, i.e. between wave 1 and wave 5. With the standard DiD approach, treatment and comparison groups are defined in terms of the wage they earn prior to each uprating. As wages are only observed in waves 1 and 5, the wage at wave 1 is used to assign individuals to the treatment or comparison group. We will experiment with two alternative ways of defining the treatment group, to explore the sensitivity of the findings to these alternative approaches:

- Workers who, before each uprating, earn more than the current NMW/NLW but less than the incoming NMW/NLW, i.e.:

$$T_{it} = 1\left[NMW_t \leq w_{it} < NMW_{t+1}\right]$$

  where T_{it} is a dummy variable equal to 1 for the treatment group and 0 otherwise; w_{it} is the individual's wage rate prior to the uprating and NMW is the NMW/NLW rate prevailing either before or after an uprating i.e. at time t or time $t+1$.

- A wage-gap definition of the treatment group, as follows:

$$T_{it} = \frac{ln\left(\frac{NMW_{t+1}}{w_{it}}\right)}{ln\left(\frac{NMW_{t+1}}{NMW_t}\right)}$$

  The above expression is equal to 0 if the individual earns exactly the incoming NMW/NLW, and is equal to 1 if the individual earns exactly the current NMW/NLW. This gives greater weight to individuals who experienced larger pay rises as a result of the minimum wage uprating and who are therefore most likely to experience employment or hours effects from a change in their wage rate.

In defining the comparison groups, we restrict our analysis to individuals who, both before and after each uprating, earn more than the incoming minimum wage. To allow meaningful comparison between the two groups, the comparison group will be restricted to those individuals whose earnings do not exceed a threshold of 10 per cent above the incoming NMW/NLW. As a robustness check we will use different definitions of the comparison group, such as workers earning between 10 per cent and 20 per cent above the NMW/NLW. The general specification of a DiD model with a single post-intervention period is:

$$Z_{it} = \alpha_0 + \alpha_1 Post + \alpha_2 T_{it} + \alpha_3 T_{it} * Post + \mathbf{X'_{it}}\boldsymbol{\alpha}_4 + \epsilon_{it} \tag{1}$$

where Z_{it} is the outcome of interest i.e. employment retention or hours following the uprating; $Post$ is a dummy variable equal to 1 in time 1 and 0 otherwise; X_{it} is a vector of individual and time-specific controls; α_0 is a constant terms; and ϵ_{it} is the error term. With several years of data we can estimate a version of model (1) in which we pool all years together and control for year fixed effects.

$$Z_{it} = \alpha_0 + \alpha_1 Post + \alpha_2 T_{it} + \alpha_3 T_{it} * Post + \mathbf{X'_{it}}\boldsymbol{\alpha}_4 + \sum_{t=2011}^{2018} \alpha_t Y_t + \epsilon_{it} \tag{2}$$

where Y_t captures the year fixed effects. The coefficient α_3 in the above model captures the average effect of all upratings on the outcomes of interest. To compare the effects of each uprating we can estimate a multi-period difference-in-differences model, which includes separate interactions between the treatment variable and the periods spanning a minimum wage uprating. For instance, with the quarterly longitudinal LFS data, denoting with W_t the periods affected by an uprating occuring in year t, the DiD model in equation 1 becomes:

$$Z_{it} = \alpha_0 + \sum_{t=2011}^{2017} \alpha_{1t} Post * W_t + \alpha_2 T_{it} + \sum_{t=2011}^{2017} \alpha_{3t} T_{it} * Post * W_t + \mathbf{X'_{it}}\boldsymbol{\alpha}_4 + \epsilon_{it} \tag{3}$$

Identification assumptions in the DiD model. There is a risk that the treatment and comparison groups experience different trends in the outcome variables over the period of analysis. If this is the case, the DiD model will not provide an accurate estimate of the impact of the NMW/NLW on the outcomes of interest. With a longitudinal dataset, such as the LFS or ASHE, it is possible to address this concern by adding an interaction between the group dummy variable and a time trend which allows for a constant rate of divergence. The DiD equation becomes:

$$Z_{it} = \alpha_0 + \alpha_1 Post + \alpha_2 T_{it} + \alpha_3 T_{it} * Post + \alpha_4 X_{it} + \alpha_5 * (t - 2011) T_{it} + \sum_{t=2011}^{2018} \alpha_t Y_t + \epsilon_{it} \tag{4}$$

For the analysis which seeks to estimate the impact of the introduction of the NLW in April 2016 using ASHE, we will follow the approach used by Aitken et al.

(2017). The years from 2016 onwards will be taken as the treatment period and the years 2011 to 2015 (when upratings were much smaller) as the pre-intervention period. As well as a baseline version of the model, we will estimate a version in which upratings of the NMW prior to the introduction of the NLW are also taken into account. The simple DiD model estimated on ASHE data, weighting the estimates by the size of the earlier upratings, is as follows:

$$Z_{it} = \alpha_0 + \alpha_1 Post + \alpha_2 T_{it} + \alpha_3 (T_{it} * Post)\omega_t + \epsilon_{it} \tag{5}$$

where ω_t is the nominal percentage change in the NMW between any two consecutive years. The introduction of the NLW is a particularly high uprating in this context, as it represents a 10.8 per cent increase in pay for those aged 25 and over.

5.2 Difference-in-differences-in-differences

As mentioned previously, a DDD approach exploits the fact that only employees aged 25 and older were eligible for the NLW, while the adult rate of the NMW was not increased for those aged between 21 and 24 until October 2016. This creates two comparison groups (previously mentioned in section 5), whose outcomes can be compared to treated individuals. Using two different comparison groups improves the chances of identifying the true effect of the introduction of the NLW as it is possible to compare the effect on the treatment group relative to the age comparison group and the effect on the treatment group relative to the wage comparison group. The difference between the two relative effects captures the impact of the introduction of the NLW.

The DDD model is:

$$\begin{aligned} Z_{it} = {} & \alpha_0 + \alpha_1 Post + \alpha_2 T_{Ait} + \alpha_3 T_{Wit} + \alpha_4 T_{Ait} * T_{Wit} + \alpha_5 T_{Ait} * Post \\ & + \alpha_6 T_{Wit} * Post + \alpha_7 T_{Wit} * T_{Ait} * Post + \alpha_8 \boldsymbol{X_{it}} + \sum_{t=2011}^{2018} \alpha_t Y_t + \epsilon_{it} \end{aligned} \tag{6}$$

where T_{Ait} takes the value of 1 where the individual belongs to the treated age group and T_{Wit} takes the value of 1 if the individual belongs to the treated wage group. The effect of the introduction of the NLW is then captured by the coefficient α_7. The DDD analysis will be based solely on analysis of ASHE, where the larger sample sizes increase the likelihood of detecting any statistically significant impacts when stratifying the comparison group.[5]

[5] We note that Aitken et al. (2017) decided not to use a DDD model due to the possibility that employers might use the NLW rate for all employees, irrespective of age. We will use a descriptive analysis of wage rates by age, before and after the introduction of the NLW, to assess the likelihood that spillover effects undermine the robustness of an analysis using a DDD approach.

6 Subgroup analysis

The final analysis will seek to explore the impact of the introduction and uprating of the NLW on the following groups of workers:

- men working full-time;
- women working full-time;
- women working part-time.

Given the current review of youth rates, we will also seek to estimate the impact of recent NMW upratings on the following subgroups:

- those eligible for the adult NMW (aged 21 to 24);
- those eligible for the development rate (aged 18 to 20);
- those eligible for the 16 to 17 year old rate.

As small sample sizes can make it difficult to produce a conclusive subgroup analysis for narrow age bands, we will experiment with pooling data on subgroups across years, following the approach taken by Bryan et al. (2013) and Bewley and Wilkinson (2015).

In addition to looking at the subgroups mentioned above, we will seek to use LFS data on whether the respondent is in education alongside working full-time or part-time to explore the interaction between education and employment for young people. Again, we will pool data across years where necessary.

We will also explore whether the impact of the NMW varies for firms of different sizes, using a similar approach to Bewley and Wilkinson (2015). Neither the LFS nor ASHE contain a direct measure of firm size and the longitudinal LFS does not include workplace size, which in the past has been used as a proxy for firm size. We will instead use the size of the reporting unit in ASHE as a proxy for firm size.

7 Further methodological issues

Brewer et al. (2015) showed that DiD analysis using the LFS has low power to detect any negative effect of the NMW on those aged 22 or more. In calculating confidence intervals they demonstrate that both large negative and large positive effects on employment retention cannot be ruled out. They also computed minimum detectable effects (MDE) and found that when using Donald and Lang (2007)'s two-step estimator, the average impact of a NMW uprating on the job retention rate would need to be around 8.6 percentage points for men or 5.4 percentage points for women to have an 80 per cent chance of being detected. They suggest a number of adjustments to improve upon the standard DiD approach:

1. Reporting 95 per cent confidence intervals associated with the null hypothesis that the NLW/NMW has no effect on employment. This indicates the magnitude of effects that can be ruled out. Related to this point, they also suggest placing less weight on statistical significance.

2. Reporting minimum detectable effects (MDE). These show how large the true elasticity of the outcome to a change in the minimum wage must be to be detected with a given probability (conventionally 80 per cent). The expression for the MDE is:

$$MDE(\pi) = \sigma(b)[c_{1-\frac{\alpha}{2}} - p^{t}_{(1-\pi)}] \tag{7}$$

   where $\sigma(b)$ is the standard error of the estimated coefficient, $c_{1-\frac{\alpha}{2}}$ is the critical value of the $(1-\frac{\alpha}{2})$th percentile of the t-distribution with $N-1$ degrees of freedom (where α denotes the significance level and N is the number of observations). $p^{t}_{(1-\pi)}$ is the $(1-\pi)$th percentile of the t-distribution with $N-1$ degrees of freedom, under the null hypothesis of no treatment effect.

3. Placing greater emphasis on the economic significance of results. In particular, they suggest that elasticities should be reported rather than the average impact of an NMW uprating so that it is easier to interpret the importance of findings. Hafner et al. (2016) also note the value of computing elasticities.

Whilst we will largely follow the approach to the analysis used by Aitken et al. (2017), we will also take account of recent critiques by reporting 95 per cent confidence intervals and minimum detectable effects (MDE) and ensuring that results focus on economic significance.

8 Descriptive analysis

This section presents a descriptive analysis of the LFS, including the use of covariate balance statistics to compare the treatment and comparison groups used in the analysis. We cannot compute balance for the employment dummy in the pre-intervention period, as our estimation sample only includes individuals who are employed in the pre-intervention period. Therefore this section focuses on differences in weekly working hours between the treatment and comparison groups from the 2011 uprating up to the 2017 NLW uprating. It also reports the balance in covariates between the treatment and comparison groups over time.[6]

[6] Table A.1 shows the sample sizes for the treatment and comparison groups, before and after each change in the NMW/NLW rates. For both the treatment and comparison groups only a very small number of individuals move from employment to non-employment between the first and fifth waves and no systematic differences in patterns between the treatment and comparison groups are apparent. Only a maximum of seven individuals left the sample between the before and after periods in any given year. Sample sizes for the treatment group in particular fluctuate from year to year, but this is likely to be largely explained by the number of individuals earning between the current and incoming NMW being greater in years when the increases in the NMW/NLW were higher. For example, the size of the treatment group is greatest in 2016 when there was a 50p rise due to the introduction of the NLW and

At present our estimation sample is made up of individuals aged 25 years and older, males and females and full-time and part-time workers. We will extend the analysis to look at younger workers in future revisions.

Table 1 shows mean working hours alongside the standard deviation and sample size for both the treatment and comparison groups.[7] The year refers to the year of uprating. The treatment group sample is smaller than the comparison group sample for all years, with the exception of 2016, in which the treatment and comparison groups were very similar in size. In 2013 the comparison group sample was almost three times the size of the treatment group. The reasons for this difference are unclear. However, it may be partly due to the fact that the October 2013 uprating was relatively small, so that few individuals were directly affected. In all years the mean working hours are higher in the comparison group than the treatment group. The differences in mean working hours between the treatment and comparison groups are statistically significant (at the 5 per cent level or better) for the 2015 uprating of the NMW, and for the introduction of the NLW in 2016, and its uprating in 2017.

Table 1: Summary statistics: weekly working hours after each uprating

	Treatment			Comparison		
Year of the uprating	**Mean**	**Std. Dev.**	**N**	**Mean**	**Std. Dev.**	**N**
2011	26.4	12.1	240	26.9	11.1	297
2012	26.8	11.2	179	27.4	11.7	331
2013	25.4	10.1	83	27.0	11.4	215
2014	26.6	10.4	217	27.7	11.6	263
2015	25.2	10.4	124	27.4	10.4	149
2016	27.2	11.0	244	30.0	11.0	239
2017	27.0	11.0	338	28.7	10.7	358

Source: LFS five quarters longitudinal datasets. Sample selection: individuals employed in the first and last quarter in which they are observed, male (aged up to 64), female (aged up to 59), full-time and part-time. Summary statistics are weighted using the longitudinal weights in the longitudinal LFS (variable lgwt).

Table 2 shows balance statistics for weekly working hours, computed over the quarters before each uprating. The table reports the mean, variance and skewness of the hours of work outcome measure for the treatment and comparison groups. It includes two measures of balance, the standardised difference and the variance ratio. The balance statistics show whether the treatment and control groups appear similar on this particular outcome prior to each uprating. If this is the case, it is more credible to believe that hours of work for the comparison group provide a good proxy for hours of work for the treatment group, had the treatment group not been subject to the uprating. The expression for the standardised difference

smallest in 2012 and 2013 when the inreases were 11p and 12p respectively.

[7] For our analysis we have dropped individuals at the top 0.5 percentile of the weekly working hours distribution, which corresponds to about eighty hours a week for each wave.

for a continuous variable is: $d = \frac{\bar{x}_t - \bar{x}_c}{\sqrt{\frac{s_t^2 - s_c^2}{2}}}$, where $\bar{x}_t$ and $\bar{x}_c$ are the sample means of variable x in the treated and control group respectively and s_t^2 and s_c^2 are the standard deviations of x in the treated and control groups respectively. The standardised difference for a dummy variable is $d = \frac{\hat{p}_t - \hat{p}_c}{\sqrt{\frac{\hat{p}_t(1-\hat{p}_t)+\hat{p}_c(1-\hat{p}_c)}{2}}}$, where $\hat{p}_t$ and $\hat{p}_c$ denote the mean of the dummy variable in the treated and control groups respectively (Flury and Riedwyl, 1986). The standardised differences should be as low as possible and the literature suggests that this should take a value no larger than ± 0.25 (Rubin, 2001). The variance ratio is simply the ratio of the variances between the treatment and comparison groups. Ideally this should be as close as possible to unity.

Table 2: Balance statistics for weekly working hours, before each uprating

Year of the uprating	Treated			Comparison			Balance	
	Mean	Variance	Skewness	Mean	Variance	Skewness	Std-diff	Var. Ratio
2011	26.0	146.9	0.312	27.0	135.3	0.161	-0.084	1.085
2012	26.4	135.1	0.509	26.9	144.1	0.223	-0.040	0.937
2013	24.8	108.4	0.283	26.11	137.2	0.401	-0.123	0.790
2014	25.5	139.1	0.433	26.6	131.8	0.039	-0.100	1.056
2015	24.4	119.6	0.069	26.3	93.1	-0.020	-0.177	1.284
2016	26.7	128.6	-0.162	28.5	114.9	-0.168	-0.161	1.119
2017	26.6	122.7	0.084	28.1	128.0	0.201	-0.129	0.958

Balance statistics are weighted using the longitudinal weights in the LFS (variable lgwt).

The magnitude of the standardized difference statistic does not exceed 0.25 prior to any uprating (Table 2). As for the variance ratio, the largest deviations from 1 are in 2013, 2015 and 2016. This suggests that the treatment and comparison groups are well-matched on weekly working hours in most cases prior to each uprating and so hours of work for the comparison group are likely to provide a reasonable estimate of what hours of work would have been for the treatment group if the NMW/NLW had not been uprated.

Appendix B shows covariate balance statistics for a wider range of pre-intervention characteristics. These have been calculated for the full list of covariates included in the regression specifications: namely age; marital status; occupation; region; level of highest qualification; the number of dependent children under the age of 16; whether the individual is white and whether they are a British national.

The results of the covariate balance statistics are generally positive. The standardised difference rarely has an absolute value in excess of 0.25. The regional and occupational variables show the highest imbalance when measured in terms of the variance ratio. Also some of the educational variables do not seem balanced in given years. Although the treatment and comparison groups appear fairly similar along other pre-intervention characteristics, the low balance displayed by some key covariates supports their inclusion as controls in our difference in differences models.

9 Preliminary findings from the LFS

This section describes the preliminary results of the analysis using the LFS five-quarters longitudinal datasets. The results are based on data spanning the period from the October to December quarter of 2010 to the January to March quarter of 2018.

We first focus on the effect of the minimum wage on employment retention and then comment on the results for weekly working hours. Throughout we focus on results which are statistically significant at the five per cent level or better, indicated by two or more asterisks in the tables. The working hours and employment retention equations are estimated (i) without controls; (ii) with a basic set of controls; and (iii) with a full set of controls. The basic controls include age, age-squared, gender and the calendar year in which these fixed effects are observed. The full set of controls additionally includes occupation, the number of months in employment, the region of residence, health status, education, ethnicity, nationality and the number of dependent children. The control variables reflect circumstances prior to the minimum wage uprating (wave 1).

Table 3 reports the difference-in-differences estimates for the employment retention equation, aggregated across all employees aged 25 or more. An important caveat when interpreting these results is that the identification of the DiD coef-

ficients is based on a very low number of observations per year, as is apparent from Appendix A. The small number of individuals in the treatment and comparison groups who move from employment to non-employment between each pre-uprating and post-uprating observation makes the impact estimates sensitive to changes of specification. These findings should therefore be treated with caution.

The only two years in which the NMW/NLW has had any discernable effect on employment retention are 2014 and 2016. The uprating of the NMW in 2014 appeared to result in an increase in employment retention across all of the specifications, whilst the introduction of the NLW in 2016 was associated with a reduction in employment retention. However, in the latter case the negative association was weak in the two models with no, or few controls. This suggests that the negative association between the introduction of the NLW and employment retention may be due to the difficulties of adequately controlling for employee characteristics when the vast majority of individuals in the LFS sample remain in employment from one year to the next, rather than because the NLW has reduced employment retention for those directly affected. Further analysis is needed to explore the robustness of this finding to other changes of specification and the larger sample sizes offered by ASHE are likely to prove more informative.

Besides the generally low levels of statistical significance, the results suggest the uprating of the NMW and introduction of the NLW has had little economic impact. The small size of the estimated coefficients means that even if the findings were statistically significant, the individuals directly affected would still have a high probability of being in employment after each uprating.

Table 4 shows the difference-in-differences results for weekly working hours. Here the coefficients can be interpreted as the effect of each uprating on the change in the number of hours worked by individuals affected by the uprating relative to the comparison group. None of the upratings have had a discernable effect on working hours in any of the specifications.

10 Summary and next steps

Our analysis so far has suggested that the introduction of the NLW has little to no impact on employment retention or hours for those directly affected. However, as previous studies have shown that employment and hours effects may be more pronounced for particular subgroups of workers (particularly women working part-time), these aggregate findings may mask important differences which will only become apparent in subsequent analyses, and in particular the analysis based on the ASHE data. The ASHE analyses will also be used to investigate the apparently positive impact of the uprating of the NMW in 2014 and the negative impact of the introduction of the NLW in 2016, since it is likely that these findings are partly due to the very small numbers of LFS respondents who leave employment from one

Table 3: Employment retention. DiD results using LFS longitudinal data, 2011-2017.

Dependent Variable: Employment Retention			
	(1)	(2)	(3)
NMW 2011	-0.023	-0.022	-0.021
s.e	(0.033)	(0.032)	(0.032)
c.i.	[-0.088; 0.041]	[-0.085; 0.041]	[-0.084; 0.041]
NMW 2012	-0.031	-0.032	-0.029
s.e	(0.034)	(0.034)	(0.034)
c.i.	[-0.099; 0.036]	[-0.099; 0.035]	[-0.095; 0.037]
NMW 2013	0.025	0.025	0.018
s.e	(0.035)	(0.035)	(0.033)
c.i.	[-0.043; 0.093]	[-0.043; 0.093]	[-0.047; 0.084]
NMW 2014	0.051**	0.052**	0.054**
s.e	(0.024)	(0.024)	(0.024)
c.i.	[0.004; 0.097]	[0.005; 0.098]	[0.007; 0.100]
NMW 2015	-0.025	-0.025	-0.025
s.e	(0.033)	(0.033)	(0.033)
c.i.	[-0.089; 0.039]	[-0.089; 0.040]	[-0.090; 0.039]
NLW 2016	-0.054*	-0.054*	-0.056**
s.e	(0.028)	(0.028)	(0.028)
c.i.	[-0.109; 0.002]	[-0.109; 0.001]	[-0.111; -0.000]
NLW 2017	0.020	0.019	0.020
s.e	(0.019)	(0.019)	(0.019)
c.i.	[-0.017; 0.057]	[-0.018; 0.056]	[-0.017; 0.057]
Controls	No	Basic	Full
Observations	6,848	6,848	6,848
R-squared	0.044	0.049	0.066
F-stat	-	8.018	3.265

*** p<0.01, ** p<0.05, * p<0.1. Sample selection: male aged between 25 and 64, female aged between 25 and 59, full-time and part-time. The regressions are weighted using the LFS longitudinal weights. Standard errors clustered at the individual level in parentheses. 95% Confidence intervals in brackets. **Basic controls:** age, age-squared, gender and survey year fixed effects. **Full controls:** basic controls plus occupation, region of residence, health status, number of months in employment, education, ethnicity, nationality, number of children. All specifications include a constant.

Table 4: Weekly working hours. DiD results using LFS longitudinal data, 2011-2017.

Dependent variable: Weekly working hours			
	(1)	(2)	(3)
NMW 2011	0.592	0.048	0.102
s.e.	(1.172)	(1.103)	(1.026)
c.i.	[-1.707; 2.891]	[-2.114; 2.211]	[-1.909; 2.113]
NMW 2012	0.542	0.508	0.633
s.e.	(1.154)	(1.035)	(1.024)
c.i.	[-1.720; 2.804]	[-1.520; 2.537]	[-1.374; 2.641]
NMW 2013	-0.470	0.474	0.494
s.e.	(1.552)	(1.471)	(1.348)
c.i.	[-3.513; 2.573]	[-2.411; 3.358]	[-2.148; 3.136]
NMW 2014	-0.045	0.270	0.255
s.e.	(1.122)	(0.998)	(0.980)
c.i.	[-2.244; 2.154]	[-1.687; 2.227]	[-1.666; 2.175]
NMW 2015	-1.157	-1.489	-1.061
s.e.	(1.445)	(1.309)	(1.293)
c.i.	[-3.990; 1.675]	[-4.055; 1.078]	[-3.597; 1.476]
NLW 2016	-1.771	-1.395	-1.433
s.e.	(1.111)	(0.985)	(0.959)
c.i.	[-3.948; 0.407]	[-3.327; 0.537]	[-3.314; 0.447]
NLW 2017	-0.513	-0.214	-0.414
s.e.	(0.880)	(0.861)	(0.811)
c.i.	[-2.239; 1.213]	[-1.902; 1.475]	[-2.005; 1.176]
Controls	No	Basic	Full
Observations	6,336	6,336	6,336
R-squared	0.007	0.159	0.248
F-stat	2.095	21.51	17.64

*** p<0.01, ** p<0.05, * p<0.1. Sample selection: male aged between 25 and 64, female aged between 25 and 59. Full-time and part-time. The regressions are weighted using the LFS longitudinal weights. Standard errors clustered at the individual level in parentheses. 95% Confidence intervals in brackets. **Basic controls:** age, age-squared, gender and survey year fixed effects. **Full controls:** basic controls plus occupation, region of residence, health status, number of months in employment, education, ethnicity, nationality, number of children. All specifications include a constant.

year to the next. The work will be extended to report the alternative specifications of the models described in section 5, including those using an alternative comparison group and the wage-gap definition of the treatment group. We will also report MDEs to explore the size of the impacts that our analysis might fail to detect and discuss the economic significance of the findings.

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Appendix A Sample sizes for the Longitudinal Labour Force Survey

A.1 Sample sizes for employment retention

Year of uprating		Treatment group			Comparison group		
		Not employed	Employed	Total	Not employed	Employed	Total
2011	Before	0	269	269	0	324	324
	After	23	242	265	23	298	321
2012	Before	0	195	195	0	359	359
	After	12	180	192	21	333	354
2013	Before	0	92	92	0	233	233
	After	8	84	92	16	215	231
2014	Before	0	236	236	0	295	295
	After	12	220	232	24	264	288
2015	Before	0	139	139	0	156	156
	After	11	125	136	5	150	155
2016	Before	0	363	363	0	252	252
	After	15	339	354	9	241	250
2017	Before	0	324	324	0	381	381
	After	23	298	321	18	358	376

Source: LFS five quarter longitudinal datasets. Male aged between 25 and 64, female aged between 25 and 59. The pre-intervention groups are observed at wave 1 of the five quarter longitudinal LFS file whilst the post-intervention groups are observed at wave 5. The sample is restricted to individuals employed in the pre-intervention period.

Appendix B Covariate balance statistics for the Longitudinal Labour Force Survey

B.1 Covariate balance statistics: 2011

	Treated			Comparison			Balance	
Variable	Mean	Variance	Skewness	Mean	Variance	Skewness	St. diff	Var. ratio
Age	41.238	119.631	0.154	40.337	119.991	0.298	0.082	0.997
Married	0.495	0.251	0.022	0.446	0.248	0.218	0.098	1.012
SOC 2010: Group 1	0.009	0.009	10.411	0.036	0.035	4.979	-0.183	0.256
SOC 2010: Group 2	0.002	0.002	19.960	0.009	0.009	10.600	-0.083	0.289
SOC 2010: Group 3	0.015	0.015	7.999	0.037	0.036	4.922	-0.138	0.415
SOC 2010: Group 4	0.061	0.057	3.682	0.080	0.074	3.094	-0.076	0.773
SOC 2010: Group 5	0.038	0.037	4.817	0.054	0.051	3.952	-0.075	0.721
SOC 2010: Group 6	0.214	0.168	1.397	0.253	0.190	1.134	-0.094	0.888
SOC 2010: Group 7	0.184	0.150	1.634	0.217	0.171	1.371	-0.084	0.881
SOC 2010: Group 8	0.125	0.110	2.266	0.070	0.065	3.385	0.188	1.692
SOC 2010: Group 9	0.352	0.229	0.618	0.244	0.185	1.190	0.237	1.236
Tyne & Wear	0.015	0.014	8.108	0.018	0.018	7.211	-0.029	0.803
Rest of Northern region	0.052	0.050	4.019	0.045	0.043	4.412	0.036	1.165
South Yorkshire	0.043	0.041	4.491	0.028	0.028	5.679	0.080	1.500
West Yorkshire	0.044	0.042	4.444	0.049	0.046	4.200	-0.021	0.911

Appendix B.1: Continued from previous page

	Treated			Comparison			Balance	
Variable	Mean	Variance	Skewness	Mean	Variance	Skewness	St. diff	Var. ratio
Rest of Yorks & Humberside	0.034	0.033	5.131	0.043	0.041	4.515	-0.045	0.804
East Midlands	0.086	0.079	2.950	0.079	0.073	3.113	0.025	1.078
East Anglia	0.048	0.046	4.239	0.064	0.060	3.566	-0.070	0.761
Inner London	0.032	0.031	5.284	0.021	0.021	6.665	0.070	1.517
Outer London	0.035	0.034	5.035	0.077	0.071	3.180	-0.181	0.481
Rest of South East	0.127	0.111	2.236	0.145	0.124	2.019	-0.051	0.898
South West	0.069	0.064	3.410	0.088	0.080	2.908	-0.072	0.797
West Midlands (met county)	0.039	0.037	4.789	0.016	0.016	7.744	0.140	2.376
Rest of West Midlands	0.060	0.057	3.707	0.053	0.051	3.981	0.029	1.119
Greater Manchester	0.085	0.078	2.974	0.050	0.047	4.145	0.141	1.649
Merseyside	0.017	0.017	7.445	0.019	0.018	7.133	-0.011	0.924
Rest of North West	0.066	0.062	3.481	0.044	0.042	4.452	0.099	1.478
Wales	0.052	0.049	4.046	0.036	0.035	4.959	0.075	1.404
Strathclyde	0.009	0.009	10.368	0.040	0.038	4.706	-0.200	0.235
Rest of Scotland	0.042	0.040	4.596	0.049	0.046	4.193	-0.035	0.859
Northern Ireland	0.044	0.043	4.425	0.037	0.036	4.872	0.035	1.176
Health condition	0.383	0.237	0.482	0.292	0.207	0.917	0.194	1.144
Degree or equivalent	0.120	0.106	2.343	0.151	0.128	1.952	-0.091	0.823
Higher education	0.052	0.049	4.048	0.115	0.102	2.415	-0.230	0.482
GCE A level or equivalent	0.212	0.167	1.411	0.229	0.177	1.290	-0.041	0.946
GCSE grades A*-C or equivalent	0.321	0.218	0.769	0.295	0.208	0.900	0.055	1.048
Other qualification	0.171	0.142	1.747	0.107	0.096	2.537	0.185	1.480
No qualification	0.125	0.110	2.265	0.103	0.093	2.610	0.069	1.184

Appendix B.1: Continued from previous page

	Treated			Comparison			Balance	
Variable	Mean	Variance	Skewness	Mean	Variance	Skewness	St. diff	Var. ratio
Number of children under 16	0.815	0.929	0.855	0.811	1.088	1.205	0.004	0.854
White	0.873	0.111	-2.247	0.883	0.103	-2.388	-0.030	1.072
British national	0.407	0.242	0.377	0.456	0.249	0.175	-0.099	0.973
Months in employment	57.030	4219.633	1.591	68.272	5186.583	2.119	-0.164	0.814

Balance statistics are weighted using the longitudinal weights in the Longitudinal Labour Force Survey (variable lgwt). A "-" indicates that the statistics cannot be computed as there are no observations for the indicated variable/groups.

B.2 Covariate balance statistics: 2012

	Treated			Comparison			Balance	
Variable	Mean	Variance	Skewness	Mean	Variance	Skewness	St. diff	Var. ratio
Age	41.515	104.248	-0.012	41.358	101.476	0.083	0.015	1.027
Married	0.507	0.251	-0.027	0.534	0.250	-0.137	-0.055	1.007
SOC 2010: Group 1	0.012	0.012	9.018	0.019	0.019	6.952	-0.061	0.615
SOC 2010: Group 2	-	-	-	0.009	0.009	10.470	-0.134	-
SOC 2010: Group 3	0.034	0.033	5.183	0.020	0.020	6.874	0.084	1.665
SOC 2010: Group 4	0.041	0.040	4.610	0.060	0.057	3.706	-0.085	0.704
SOC 2010: Group 5	0.066	0.062	3.483	0.062	0.058	3.644	0.019	1.074
SOC 2010: Group 6	0.095	0.087	2.761	0.178	0.147	1.683	-0.243	0.589
SOC 2010: Group 7	0.200	0.161	1.501	0.257	0.192	1.110	-0.137	0.839
SOC 2010: Group 8	0.101	0.091	2.656	0.074	0.069	3.245	0.093	1.318
SOC 2010: Group 9	0.451	0.249	0.195	0.320	0.218	0.770	0.271	1.140
Tyne & Wear	0.015	0.015	7.987	0.028	0.027	5.711	-0.090	0.542
Rest of Northern region	0.037	0.036	4.904	0.045	0.043	4.399	-0.039	0.835
South Yorkshire	0.034	0.033	5.102	0.032	0.031	5.286	0.012	1.067
West Yorkshire	0.052	0.050	4.022	0.059	0.056	3.732	-0.030	0.891
Rest of Yorks & Humberside	0.033	0.032	5.214	0.040	0.038	4.706	-0.035	0.841
East Midlands	0.121	0.107	2.322	0.099	0.090	2.683	0.070	1.196
East Anglia	0.045	0.043	4.418	0.036	0.035	4.975	0.043	1.226
Inner London	-	-	-	0.023	0.023	6.331	-0.218	-
Outer London	0.058	0.055	3.791	0.039	0.038	4.765	0.088	1.458
Rest of South East	0.170	0.142	1.756	0.191	0.155	1.568	-0.055	0.914
South West	0.096	0.087	2.752	0.126	0.110	2.256	-0.097	0.788

Appendix B.2: Continued from previous page

	Treated			Comparison			Balance	
Variable	Mean	Variance	Skewness	Mean	Variance	Skewness	St. diff	Var. ratio
West Midlands (met county)	0.015	0.014	8.092	0.020	0.020	6.805	-0.043	0.726
Rest of West Midlands	0.040	0.038	4.709	0.047	0.044	4.306	-0.033	0.864
Greater Manchester	0.027	0.027	5.824	0.064	0.060	3.570	-0.176	0.443
Merseyside	0.043	0.041	4.520	0.007	0.007	11.843	0.231	5.921
Rest of North West	0.081	0.075	3.075	0.026	0.025	6.010	0.247	2.989
Wales	0.064	0.061	3.549	0.052	0.049	4.035	0.053	1.226
Strathclyde	0.045	0.043	4.418	0.012	0.012	8.779	0.193	3.457
Rest of Scotland	0.010	0.010	9.986	0.029	0.028	5.614	-0.140	0.343
Northern Ireland	0.015	0.015	7.929	0.024	0.024	6.184	-0.065	0.633
Health condition	0.327	0.221	0.737	0.301	0.211	0.869	0.057	1.050
Degree or equivalent	0.074	0.069	3.246	0.112	0.100	2.456	-0.131	0.692
Higher education	0.042	0.040	4.587	0.070	0.065	3.370	-0.124	0.615
GCE A level or equivalent	0.123	0.109	2.290	0.201	0.161	1.488	-0.213	0.674
GCSE grades A*-C or equivalent	0.361	0.232	0.578	0.370	0.234	0.538	-0.018	0.992
Other qualification	0.195	0.158	1.538	0.156	0.132	1.895	0.103	1.196
No qualification	0.204	0.163	1.468	0.090	0.082	2.866	0.326	1.990
Number of children under 16	0.802	1.037	1.156	0.771	1.035	1.350	0.030	1.002
White	0.903	0.088	-2.727	0.903	0.088	-2.727	0.000	1.003
British national	0.375	0.236	0.517	0.352	0.229	0.619	0.047	1.030
Months in employment	56.548	3606.246	1.832	69.574	5567.868	1.698	-0.192	0.648

Balance statistics are weighted using the longitudinal weights in the Longitudinal Labour Force Survey (variable lgwt). A "-" indicates that the statistics cannot be computed as there are no observations for the indicated variable/groups.

B.3 Covariate balance statistics: 2013

	Treated			Comparison			Balance	
Variable	Mean	Variance	Skewness	Mean	Variance	Skewness	St. diff	Var. ratio
Age	39.103	116.755	0.323	40.782	107.157	0.260	-0.159	1.090
Married	0.427	0.247	0.295	0.446	0.248	0.218	-0.038	0.997
SOC 2010: Group 1	-	-	-	0.007	0.007	11.808	-0.119	-
SOC 2010: Group 2	0.006	0.006	12.722	0.006	0.006	12.870	0.002	1.030
SOC 2010: Group 3	0.023	0.023	6.306	0.013	0.013	8.684	0.080	1.827
SOC 2010: Group 4	0.066	0.062	3.498	0.038	0.037	4.802	0.123	1.677
SOC 2010: Group 5	0.014	0.014	8.204	0.061	0.057	3.680	-0.246	0.248
SOC 2010: Group 6	0.253	0.191	1.137	0.182	0.150	1.648	0.172	1.277
SOC 2010: Group 7	0.253	0.191	1.135	0.236	0.181	1.242	0.039	1.055
SOC 2010: Group 8	0.091	0.083	2.854	0.101	0.091	2.653	-0.034	0.915
SOC 2010: Group 9	0.294	0.210	0.906	0.356	0.230	0.601	-0.133	0.911
Tyne & Wear	0.036	0.035	4.958	0.017	0.017	7.493	0.120	2.119
Rest of Northern region	0.033	0.032	5.268	0.030	0.029	5.548	0.017	1.103
South Yorkshire	0.047	0.045	4.306	0.037	0.036	4.914	0.048	1.257
West Yorkshire	0.113	0.102	2.438	0.048	0.046	4.224	0.240	2.211
Rest of Yorks & Humberside	0.038	0.037	4.826	0.056	0.053	3.862	-0.084	0.698
East Midlands	0.076	0.071	3.203	0.087	0.080	2.923	-0.042	0.886
East Anglia	0.049	0.047	4.177	0.035	0.033	5.099	0.072	1.408
Inner London	0.040	0.039	4.670	-	-	-	0.288	-
Outer London	0.078	0.073	3.153	0.038	0.037	4.828	0.170	1.972
Rest of South East	0.187	0.154	1.604	0.171	0.142	1.747	0.042	1.080
South West	0.038	0.037	4.856	0.101	0.091	2.649	-0.250	0.402

Appendix B.3: Continued from previous page

	Treated			Comparison			Balance	
Variable	Mean	Variance	Skewness	Mean	Variance	Skewness	St. diff	Var. ratio
West Midlands (met county)	0.015	0.015	7.992	0.039	0.038	4.729	-0.151	0.391
Rest of West Midlands	0.012	0.012	9.100	0.049	0.046	4.201	-0.217	0.251
Greater Manchester	0.055	0.053	3.885	0.046	0.044	4.346	0.044	1.206
Merseyside	0.006	0.006	12.547	0.070	0.066	3.361	-0.338	0.095
Rest of North West	0.053	0.051	3.972	0.009	0.009	10.224	0.254	5.524
Wales	0.036	0.035	4.974	0.084	0.077	3.010	-0.200	0.458
Strathclyde	0.038	0.037	4.835	0.023	0.022	6.428	0.090	1.667
Rest of Scotland	0.037	0.036	4.924	0.052	0.049	4.047	-0.073	0.726
Northern Ireland	0.013	0.013	8.747	0.009	0.009	10.274	0.032	1.370
Health condition	0.354	0.231	0.608	0.275	0.200	1.005	0.170	1.154
Degree or equivalent	0.138	0.121	2.095	0.089	0.081	2.891	0.156	1.483
Higher education	0.045	0.043	4.395	0.065	0.061	3.513	-0.090	0.706
GCE A level or equivalent	0.230	0.179	1.284	0.227	0.176	1.303	0.007	1.015
GCSE grades A*-C or equivalent	0.302	0.213	0.864	0.328	0.221	0.732	-0.057	0.962
Other qualification	0.181	0.150	1.660	0.159	0.134	1.867	0.058	1.116
No qualification	0.105	0.095	2.585	0.132	0.115	2.178	-0.084	0.824
Number of children under 16	0.936	1.096	1.243	0.933	1.345	1.274	0.002	0.815
White	0.803	0.160	-1.522	0.867	0.116	-2.158	-0.172	1.380
British national	0.439	0.249	0.245	0.420	0.245	0.324	0.039	1.018
Months in employment	55.656	4777.404	2.079	62.038	3870.726	1.420	-0.097	1.234

Balance statistics are weighted using the longitudinal weights in the Longitudinal Labour Force Survey (variable lgwt). A "-" indicates that the statistics cannot be computed as there are no observations for the indicated variable/groups.

B.4 Covariate balance statistics: 2014

	Treated			Comparison			Balance	
Variable	Mean	Variance	Skewness	Mean	Variance	Skewness	St. diff	Var. ratio
Age	40.913	110.909	0.125	40.244	108.316	0.296	0.064	1.024
Married	0.405	0.242	0.389	0.445	0.248	0.223	-0.081	0.976
SOC 2010: Group 1	0.006	0.006	12.682	0.019	0.019	7.049	-0.116	0.326
SOC 2010: Group 2	0.005	0.005	13.862	0.003	0.003	17.546	0.030	1.591
SOC 2010: Group 3	0.026	0.025	5.992	0.025	0.024	6.130	0.007	1.043
SOC 2010: Group 4	0.041	0.040	4.607	0.085	0.078	2.973	-0.180	0.509
SOC 2010: Group 5	0.070	0.066	3.362	0.089	0.081	2.886	-0.069	0.807
SOC 2010: Group 6	0.144	0.124	2.032	0.180	0.148	1.667	-0.098	0.835
SOC 2010: Group 7	0.227	0.176	1.302	0.222	0.173	1.339	0.013	1.018
SOC 2010: Group 8	0.080	0.074	3.095	0.083	0.077	3.015	-0.012	0.965
SOC 2010: Group 9	0.401	0.241	0.406	0.294	0.208	0.905	0.225	1.158
Tyne & Wear	0.027	0.026	5.830	0.018	0.018	7.283	0.062	1.503
Rest of Northern region	0.053	0.050	3.989	0.038	0.037	4.814	0.071	1.366
South Yorkshire	0.030	0.029	5.547	0.034	0.033	5.134	-0.025	0.874
West Yorkshire	0.064	0.060	3.560	0.068	0.064	3.432	-0.016	0.947
Rest of Yorks & Humberside	0.047	0.045	4.262	0.049	0.047	4.175	-0.008	0.968
East Midlands	0.135	0.117	2.142	0.064	0.060	3.576	0.238	1.956
East Anglia	0.025	0.024	6.116	0.044	0.042	4.448	-0.105	0.575
Inner London	0.015	0.015	8.076	0.037	0.035	4.940	-0.139	0.411
Outer London	0.026	0.025	6.010	0.052	0.049	4.045	-0.136	0.508
Rest of South East	0.117	0.104	2.377	0.118	0.105	2.361	-0.003	0.993
South West	0.059	0.055	3.760	0.077	0.072	3.164	-0.075	0.773

Appendix B.4: Continued from previous page

	Treated			Comparison			Balance	
Variable	Mean	Variance	Skewness	Mean	Variance	Skewness	St. diff	Var. ratio
West Midlands (met county)	0.086	0.079	2.962	0.066	0.062	3.503	0.075	1.275
Rest of West Midlands	0.020	0.020	6.868	0.038	0.037	4.807	-0.109	0.530
Greater Manchester	0.030	0.030	5.465	0.034	0.033	5.120	-0.022	0.893
Merseyside	0.032	0.031	5.296	0.019	0.018	7.123	0.086	1.709
Rest of North West	0.044	0.042	4.440	0.067	0.063	3.459	-0.100	0.674
Wales	0.107	0.096	2.547	0.035	0.034	5.029	0.280	2.795
Strathclyde	0.036	0.035	4.953	0.045	0.043	4.403	-0.042	0.820
Rest of Scotland	0.039	0.038	4.759	0.058	0.055	3.768	-0.090	0.684
Northern Ireland	0.009	0.009	10.501	0.038	0.037	4.817	-0.195	0.238
Health condition	0.361	0.232	0.580	0.374	0.235	0.520	-0.028	0.986
Degree or equivalent	0.088	0.081	2.898	0.101	0.091	2.641	-0.044	0.886
Higher education	0.052	0.049	4.037	0.090	0.082	2.865	-0.148	0.602
GCE A level or equivalent	0.168	0.140	1.776	0.225	0.175	1.316	-0.144	0.802
GCSE grades A*-C or equivalent	0.357	0.231	0.595	0.326	0.220	0.744	0.067	1.047
Other qualification	0.202	0.162	1.484	0.155	0.131	1.907	0.123	1.233
No qualification	0.132	0.115	2.174	0.103	0.093	2.613	0.090	1.242
Number of children under 16	0.837	0.973	0.850	0.883	1.042	0.769	-0.046	0.934
White	0.895	0.094	-2.576	0.914	0.079	-2.953	-0.065	1.197
British national	0.426	0.246	0.298	0.405	0.242	0.387	0.043	1.016
Months in employment	49.425	3913.795	2.633	66.309	5453.737	1.883	-0.247	0.718

Balance statistics are weighted using the longitudinal weights in the Longitudinal Labour Force Survey (variable lgwt). A "-" indicates that the statistics cannot be computed as there are no observations for the indicated variable/groups.

B.5 Covariate balance statistics: 2015

	Treated			Comparison			Balance	
Variable	Mean	Variance	Skewness	Mean	Variance	Skewness	St. diff	Var. ratio
Age	40.813	118.164	0.118	40.026	103.963	0.092	0.075	1.137
Married	0.409	0.243	0.372	0.425	0.246	0.303	-0.033	0.990
SOC 2010: Group 1	0.010	0.010	10.035	0.009	0.009	10.613	0.010	1.115
SOC 2010: Group 2	-	-	-	0.006	0.006	13.069	-0.107	-
SOC 2010: Group 3	-	-	-	0.018	0.018	7.290	-0.190	-
SOC 2010: Group 4	0.038	0.037	4.820	0.082	0.076	3.054	-0.184	0.490
SOC 2010: Group 5	0.048	0.046	4.235	0.039	0.038	4.735	0.041	1.205
SOC 2010: Group 6	0.117	0.104	2.383	0.304	0.213	0.855	-0.469	0.489
SOC 2010: Group 7	0.225	0.176	1.316	0.252	0.190	1.140	-0.064	0.925
SOC 2010: Group 8	0.099	0.090	2.683	0.077	0.072	3.170	0.077	1.256
SOC 2010: Group 9	0.463	0.250	0.148	0.214	0.169	1.397	0.545	1.481
Tyne & Wear	0.050	0.048	4.146	0.033	0.032	5.246	0.085	1.489
Rest of Northern region	0.062	0.058	3.647	0.018	0.017	7.326	0.226	3.336
South Yorkshire	0.010	0.010	9.663	0.025	0.025	6.047	-0.112	0.417
West Yorkshire	0.067	0.063	3.463	0.036	0.035	4.990	0.141	1.809
Rest of Yorks & Humberside	0.071	0.067	3.335	0.016	0.016	7.641	0.270	4.128
East Midlands	0.097	0.088	2.723	0.129	0.113	2.215	-0.100	0.781
East Anglia	0.031	0.030	5.435	0.054	0.051	3.950	-0.115	0.585
Inner London	0.024	0.023	6.268	0.046	0.044	4.338	-0.121	0.528
Outer London	0.065	0.061	3.535	0.031	0.031	5.373	0.156	1.994
Rest of South East	0.154	0.132	1.912	0.175	0.146	1.706	-0.056	0.903
South West	0.091	0.084	2.835	0.088	0.081	2.909	0.012	1.036

Appendix B.5: Continued from previous page

	Treated			Comparison			Balance	
Variable	Mean	Variance	Skewness	Mean	Variance	Skewness	St. diff	Var. ratio
West Midlands (met county)	0.039	0.038	4.746	0.061	0.058	3.652	-0.101	0.654
Rest of West Midlands	0.014	0.014	8.157	0.041	0.040	4.625	-0.163	0.360
Greater Manchester	0.038	0.037	4.838	0.064	0.061	3.554	-0.119	0.607
Merseyside	0.024	0.024	6.172	0.028	0.027	5.758	-0.021	0.884
Rest of North West	0.035	0.034	5.077	0.062	0.058	3.642	-0.126	0.580
Wales	0.066	0.062	3.502	0.041	0.040	4.604	0.108	1.550
Strathclyde	-	-	-	-	-	-	-	-
Rest of Scotland	0.008	0.008	11.360	0.037	0.036	4.933	-0.198	0.213
Northern Ireland	0.054	0.051	3.952	0.014	0.014	8.205	0.219	3.639
Health condition	0.397	0.241	0.421	0.338	0.225	0.685	0.122	1.071
Degree or equivalent	0.150	0.129	1.956	0.126	0.111	2.251	0.070	1.160
Higher education	0.074	0.069	3.269	0.077	0.072	3.174	-0.013	0.959
GCE A level or equivalent	0.165	0.139	1.802	0.254	0.191	1.131	-0.218	0.729
GCSE grades A*-C or equivalent	0.256	0.192	1.115	0.289	0.207	0.933	-0.072	0.930
Other qualification	0.249	0.189	1.158	0.165	0.139	1.806	0.209	1.361
No qualification	0.105	0.095	2.580	0.089	0.082	2.877	0.052	1.153
Number of children under 16	0.721	0.874	0.988	0.849	1.355	2.795	-0.121	0.645
White	0.877	0.108	-2.300	0.853	0.126	-1.998	0.070	0.861
British national	0.474	0.251	0.105	0.460	0.250	0.160	0.028	1.004
Months in employment	48.929	2928.600	1.772	69.851	5568.618	2.124	-0.321	0.526

Balance statistics are weighted using the longitudinal weights in the Longitudinal Labour Force Survey (variable lgwt). A "-" indicates that the statistics cannot be computed as there are no observations for the indicated variable/groups.

B.6 Covariate balance statistics: 2016

	Treated			Comparison			Balance	
Variable	Mean	Variance	Skewness	Mean	Variance	Skewness	St. diff	Var. ratio
Age	40.666	116.748	0.209	41.839	117.422	0.025	-0.108	0.994
Married	0.465	0.250	0.141	0.423	0.245	0.310	0.083	1.019
SOC 2010: Group 1	0.019	0.018	7.136	0.004	0.004	15.343	0.135	4.358
SOC 2010: Group 2	0.009	0.009	10.213	0.013	0.013	8.529	-0.037	0.708
SOC 2010: Group 3	0.005	0.005	14.473	0.013	0.013	8.729	-0.085	0.376
SOC 2010: Group 4	0.043	0.041	4.525	0.113	0.100	2.451	-0.263	0.409
SOC 2010: Group 5	0.048	0.046	4.244	0.047	0.045	4.257	0.001	1.005
SOC 2010: Group 6	0.221	0.173	1.345	0.217	0.171	1.371	0.009	1.012
SOC 2010: Group 7	0.217	0.171	1.373	0.191	0.155	1.571	0.064	1.098
SOC 2010: Group 8	0.086	0.079	2.945	0.098	0.089	2.709	-0.039	0.894
SOC 2010: Group 9	0.353	0.229	0.616	0.304	0.212	0.854	0.105	1.080
Tyne & Wear	0.031	0.030	5.454	0.016	0.016	7.638	0.094	1.847
Rest of Northern region	0.036	0.034	5.010	0.048	0.046	4.233	-0.061	0.753
South Yorkshire	0.022	0.021	6.563	0.024	0.023	6.237	-0.014	0.911
West Yorkshire	0.060	0.057	3.700	0.040	0.038	4.706	0.093	1.478
Rest of Yorks & Humberside	0.021	0.021	6.618	0.035	0.034	5.037	-0.084	0.614
East Midlands	0.132	0.115	2.172	0.077	0.071	3.183	0.182	1.621
East Anglia	0.042	0.040	4.562	0.060	0.057	3.695	-0.083	0.711
Inner London	0.015	0.015	8.063	-	-	-	0.172	-
Outer London	0.029	0.028	5.641	0.059	0.056	3.744	-0.148	0.503
Rest of South East	0.086	0.079	2.953	0.173	0.144	1.725	-0.262	0.548
South West	0.117	0.103	2.390	0.112	0.100	2.468	0.016	1.039

Appendix B.6: Continued from previous page

	Treated			Comparison			Balance	
Variable	Mean	Variance	Skewness	Mean	Variance	Skewness	St. diff	Var. ratio
West Midlands (met county)	0.038	0.036	4.858	0.033	0.032	5.230	0.025	1.136
Rest of West Midlands	0.051	0.049	4.076	0.045	0.043	4.390	0.029	1.129
Greater Manchester	0.075	0.069	3.237	0.046	0.044	4.321	0.119	1.565
Merseyside	0.012	0.012	8.865	0.010	0.010	9.998	0.024	1.258
Rest of North West	0.031	0.030	5.439	0.037	0.036	4.872	-0.037	0.825
Wales	0.069	0.065	3.394	0.045	0.043	4.397	0.105	1.503
Strathclyde	0.011	0.011	9.546	0.031	0.030	5.453	-0.141	0.355
Rest of Scotland	0.059	0.056	3.741	0.080	0.074	3.092	-0.083	0.753
Northern Ireland	0.065	0.061	3.529	0.029	0.028	5.626	0.171	2.166
Health condition	0.434	0.247	0.267	0.328	0.221	0.731	0.218	1.114
Degree or equivalent	0.107	0.096	2.551	0.107	0.096	2.539	-0.002	0.994
Higher education	0.098	0.088	2.713	0.063	0.060	3.586	0.126	1.483
GCE A level or equivalent	0.233	0.180	1.262	0.228	0.177	1.293	0.011	1.014
GCSE grades A*-C or equivalent	0.300	0.211	0.875	0.322	0.219	0.761	-0.049	0.960
Other qualification	0.160	0.135	1.858	0.171	0.142	1.747	-0.030	0.946
No qualification	0.103	0.093	2.604	0.108	0.097	2.530	-0.014	0.965
Number of children under 16	0.811	0.961	1.038	0.691	0.900	1.224	0.124	1.068
White	0.829	0.142	-1.751	0.922	0.072	-3.145	-0.283	1.965
British national	0.376	0.235	0.512	0.477	0.250	0.093	-0.204	0.940
Months in employment	61.913	4830.221	1.468	71.022	6129.769	1.863	-0.123	0.788

Balance statistics are weighted using the longitudinal weights in the Longitudinal Labour Force Survey (variable lgwt). A "-" indicates that the statistics cannot be computed as there are no observations for the indicated variable/groups.

B.7 Covariate balance statistics: 2017

	Treated			Comparison			Balance	
Variable	Mean	Variance	Skewness	Mean	Variance	Skewness	St. diff	Var. ratio
Age	41.238	119.631	0.154	40.337	119.991	0.298	0.082	0.997
Married	0.495	0.251	0.022	0.446	0.248	0.218	0.098	1.012
SOC 2010: Group 1	0.009	0.009	10.411	0.036	0.035	4.979	-0.183	0.256
SOC 2010: Group 2	0.002	0.002	19.960	0.009	0.009	10.600	-0.083	0.289
SOC 2010: Group 3	0.015	0.015	7.999	0.037	0.036	4.922	-0.138	0.415
SOC 2010: Group 4	0.061	0.057	3.682	0.080	0.074	3.094	-0.076	0.773
SOC 2010: Group 5	0.038	0.037	4.817	0.054	0.051	3.952	-0.075	0.721
SOC 2010: Group 6	0.214	0.168	1.397	0.253	0.190	1.134	-0.094	0.888
SOC 2010: Group 7	0.184	0.150	1.634	0.217	0.171	1.371	-0.084	0.881
SOC 2010: Group 8	0.125	0.110	2.266	0.070	0.065	3.385	0.188	1.692
SOC 2010: Group 9	0.352	0.229	0.618	0.244	0.185	1.190	0.237	1.236
Tyne & Wear	0.015	0.014	8.108	0.018	0.018	7.211	-0.029	0.803
Rest of Northern region	0.052	0.050	4.019	0.045	0.043	4.412	0.036	1.165
South Yorkshire	0.043	0.041	4.491	0.028	0.028	5.679	0.080	1.500
West Yorkshire	0.044	0.042	4.444	0.049	0.046	4.200	-0.021	0.911
Rest of Yorks & Humberside	0.034	0.033	5.131	0.043	0.041	4.515	-0.045	0.804
East Midlands	0.086	0.079	2.950	0.079	0.073	3.113	0.025	1.078
East Anglia	0.048	0.046	4.239	0.064	0.060	3.566	-0.070	0.761
Inner London	0.032	0.031	5.284	0.021	0.021	6.665	0.070	1.517
Outer London	0.035	0.034	5.035	0.077	0.071	3.180	-0.181	0.481
Rest of South East	0.127	0.111	2.236	0.145	0.124	2.019	-0.051	0.898
South West	0.069	0.064	3.410	0.088	0.080	2.908	-0.072	0.797

Appendix B.7: Continued from previous page

	Treated			Comparison			Balance	
Variable	Mean	Variance	Skewness	Mean	Variance	Skewness	St. diff	Var. ratio
West Midlands (met county)	0.039	0.037	4.789	0.016	0.016	7.744	0.140	2.376
Rest of West Midlands	0.060	0.057	3.707	0.053	0.051	3.981	0.029	1.119
Greater Manchester	0.085	0.078	2.974	0.050	0.047	4.145	0.141	1.649
Merseyside	0.017	0.017	7.445	0.019	0.018	7.133	-0.011	0.924
Rest of North West	0.066	0.062	3.481	0.044	0.042	4.452	0.099	1.478
Wales	0.052	0.049	4.046	0.036	0.035	4.959	0.075	1.404
Strathclyde	0.009	0.009	10.368	0.040	0.038	4.706	-0.200	0.235
Rest of Scotland	0.042	0.040	4.596	0.049	0.046	4.193	-0.035	0.859
Northern Ireland	0.044	0.043	4.425	0.037	0.036	4.872	0.035	1.176
Health condition	0.383	0.237	0.482	0.292	0.207	0.917	0.194	1.144
Degree or equivalent	0.120	0.106	2.343	0.151	0.128	1.952	-0.091	0.823
Higher education	0.052	0.049	4.048	0.115	0.102	2.415	-0.230	0.482
GCE A level or equivalent	0.212	0.167	1.411	0.229	0.177	1.290	-0.041	0.946
GCSE grades A*-C or equivalent	0.321	0.218	0.769	0.295	0.208	0.900	0.055	1.048
Other qualification	0.171	0.142	1.747	0.107	0.096	2.537	0.185	1.480
No qualification	0.125	0.110	2.265	0.103	0.093	2.610	0.069	1.184
Number of children under 16	0.815	0.929	0.855	0.811	1.088	1.205	0.004	0.854
White	0.873	0.111	-2.247	0.883	0.103	-2.388	-0.030	1.072
British national	0.407	0.242	0.377	0.456	0.249	0.175	-0.099	0.973
Months in employment	57.030	4219.633	1.591	68.272	5186.583	2.119	-0.164	0.814

Balance statistics are weighted using the longitudinal weigths in the Longitudinal Labour Force Survey (variable lgwt). A "-" indicates that the statistics cannot be computed as there are no observations for the indicated variable/groups.